

Oct. 25, 1932.

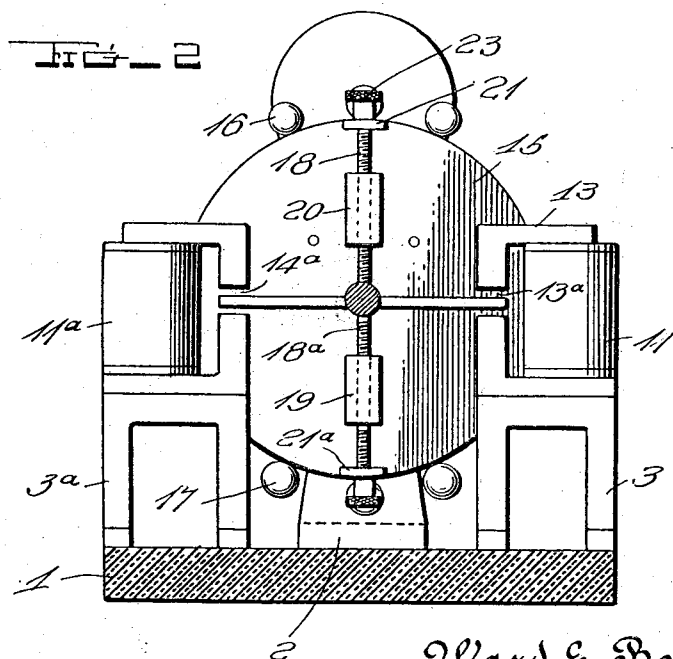
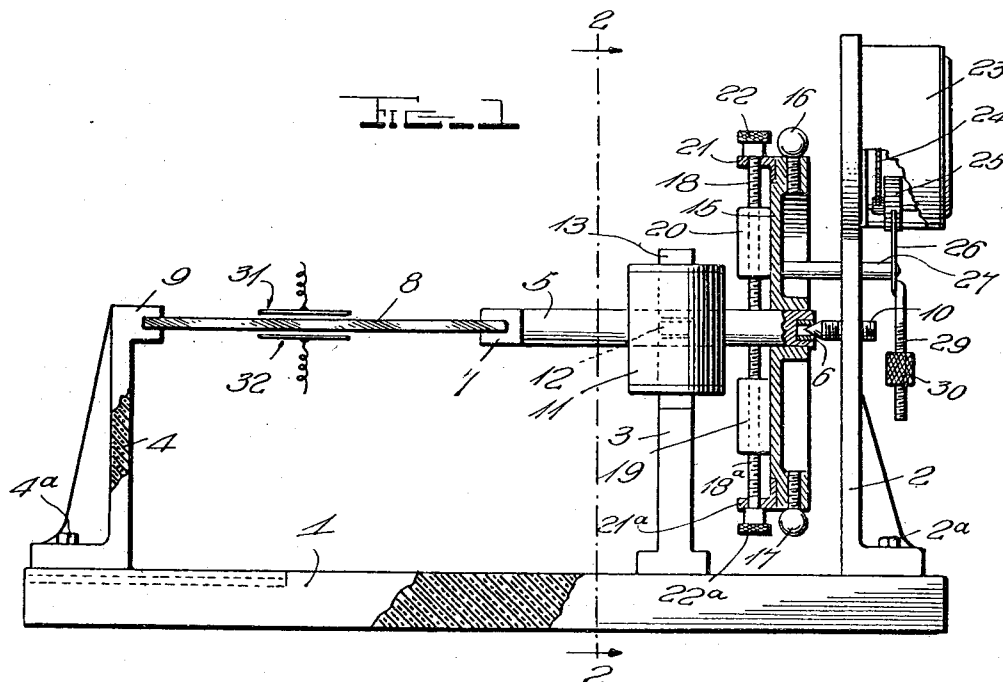
W. E. BOWER

1,884,547

ELECTRICAL GENERATING SYSTEM

Filed March 9, 1929

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

FIG. 3

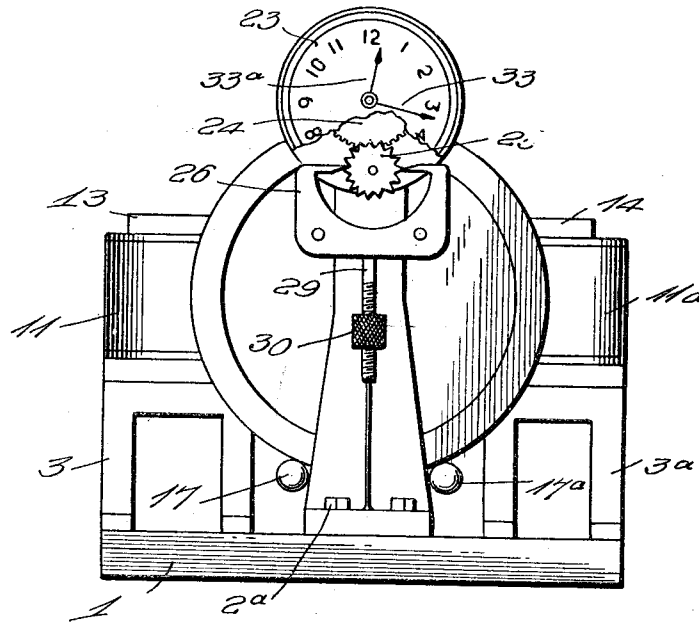
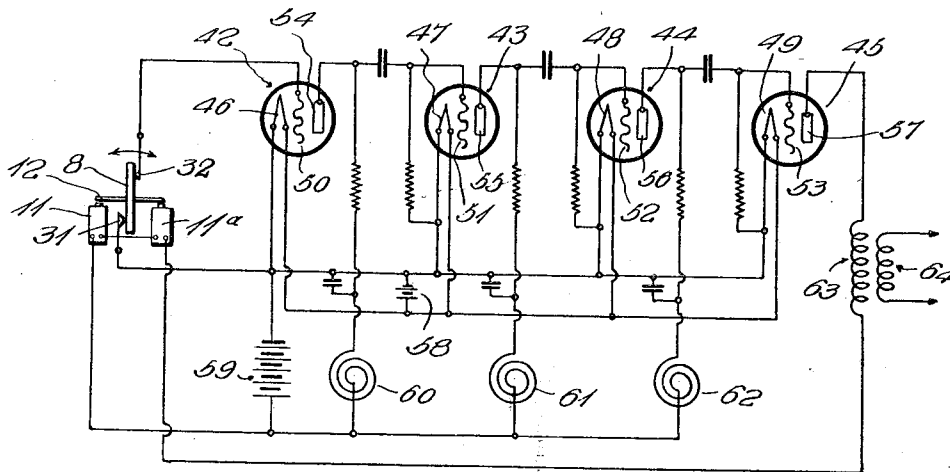


FIG. 2



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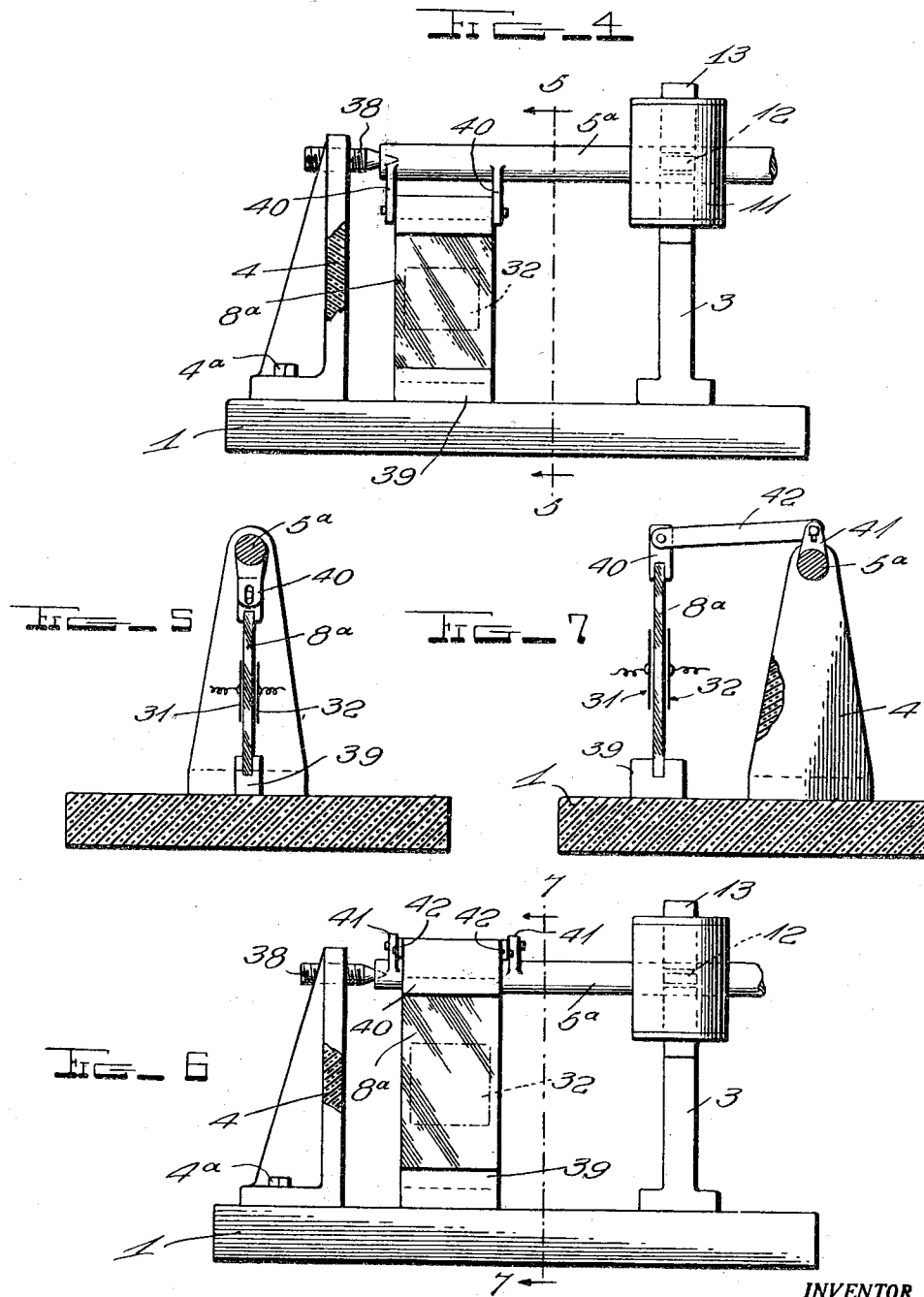
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ELECTRICAL GENERATING SYSTEM

Filed March 9, 1929

3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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ELECTRICAL GENERATING SYSTEM

Application filed March 9, 1929. Serial No. 345,873.

My invention relates broadly to electrical generating systems generally and more particularly to systems for the generation of alternating current.

One of the objects of my invention is to provide a system for the generation of electrical energy by means of the setting up of differences in mechanical tension.

Another object of my invention is to provide a system for the generation of alternating current of a definite frequency.

Still another object of my invention is to provide a system for the generation of low frequency alternating current.

A further object of my invention is to provide a system for the generation of low frequency electrical energy by mechanical tension means reacting on piezo electric elements.

A still further object of my invention is to provide a system for generating low frequency alternating current by mechanical tension and piezo electric forces whereby the frequency of the generated current is readily determined.

Other and further objects of my invention will be understood from the specification hereinafter following by reference to the accompanying drawings, wherein:

Figure 1 shows a side elevation of the apparatus of my invention, partly in section; Fig. 2 shows a rear end view of the apparatus of my invention in part section; Fig. 3 shows a front view of the apparatus of Fig. 1 in part section; Figs. 4 and 5 show side and end views respectively in part section of a modification of my invention; Figs. 6 and 7 show similar views of other modifications of my invention; and Fig. 8 is a schematic circuit diagram showing the application and operation of the generating system of my invention.

Fig. 1 shows a side elevation of a preferred form of my invention. A base 1 of suitable material supports the apparatus as shown. Upstanding members 2, 3 and 4 are positioned on base 1 and serve to support the mechanism proper. Members 2 and 4 are positioned on base 1 by means of screws 2a and 4a respectively. A shaft 5 is supported at one end by bearing 6 and set screw 10 thread-

ed through upstanding member 2. The other end of shaft 5 is provided with a notch or recess 7 in which one end of a piezo electric crystal element 8 is retained. Piezo electric crystal element 8 may comprise a bar or rod of quartz or of suitable metal such as steel. The elasticity of bar 8 should be sufficiently great to withstand the operation, later to be described in detail. Bar or rod 8 may be of metal veneered with thin layers or strata of quartz or its equivalent.

The other end of rod 8 is positioned in recess 9 provided in the upper end of member 4. The positioning of rod 8 in recess 9 is positive with respect to the normal movement of shaft 5. However, a set screw or suitable clamping means may be provided associated with member 4, whereby rod 8 may be removed and another substituted having physical dimensions or elasticity differing from the former. An electromagnet 11, supported by upstanding member 3, has an iron core member 13 which is closed with the exception of the space for member 12. Member 12, of suitable magnetic material, is carried by shaft 5. The relation of core 13 and member 12 is more fully illustrated in Fig. 2. A balance wheel 15 is provided on shaft 5 and is of suitable design and weight to contribute to the movement of shaft 5. Suitable weights 16 and 17 may be positioned around the periphery of wheel 15 to adjust the inertia of the movable system. These weights may be provided with threaded screws whereby their removal may be facilitated. Adjustable weights 19 and 20 may be supported by angle members 21 and 21a, threaded on rods 18 and 18a. The adjustment of rods 18 and 18a determining the positioning of weights 19 and 20, is effected through knurled nuts 22 and 22a. An indicating mechanism 23 is supported by upstanding member 2. Indicating mechanism 23 resembles a clock in that a gear train 24 is associated with an escapement mechanism 25—26 and pendulum 29. Escapement mechanism 25—26 is connected with rod member 27, the latter being connected to the balance wheel 15 and being movable therewith. Pendulum 29 may or may not be employed, as desired, and when the same is em-

ployed, it may be provided with suitable weights 30 adapted to increase or decrease the period of oscillation.

Fig. 2 of the drawings shows the association of armature member 12 and electromagnet 11 in greater detail. Electromagnets 11 and 11a are of similar design, each having core members 13 and 14 nearly of the closed core design. Air gaps 13a and 14a are provided in cores 13 and 14 respectively, which gaps are of the proper dimensions to permit the movement of armature member 12 within certain limits. Armature member 12 is carried by shaft 5. Balance wheel 15 and other associated parts are shown in greater detail, and indicated by reference characters corresponding to like members in all of the figures. Weights 19 and 20 are adjustably carried by wheel 15, the direction or adjustment being toward the periphery of wheel 15 or at right angles to shaft 5. Moving the weights to positions nearer to the periphery of wheel 15 tends to increase the centrifugal force of the wheel or inertia of movement thereof.

Fig. 3 shows a front end view, wherein indicating mechanism 23 is illustrated in greater detail. By observing Figs. 2 and 3 the operation of indicating mechanism 23 and its association with the reciprocating motion of shaft 5, aided by wheel 15, is clearly discerned. The rocking motion of shaft 5 and armature member 12 is transmitted to escapement mechanism 25—26 which is in turn transmitted to gear train 24. Gear train 24 is associated with indicating hands 33 or 33a. Either hand 33 or 33a may be associated with suitable spring and gear mechanism having a balance wheel and operable independently with respect to each other.

In the latter arrangement, assuming that the actuation of escapement mechanism 25—26 moves hand 33, hand 33a would move according to time alone, uninfluenced in its movement by that of hand 33. In such an arrangement the relative movement of one hand with respect to the other would be easily discerned and it would be a simple procedure to determine the number of oscillations of member 26 which occurred in a given time as indicated by the other hand. A second hand may be provided whereby the number of oscillations per second of time may be determined entirely and accurately by observing the position of the several hands. A separate hand may be employed controlled solely by an independent gear train and spring mechanism for indicating the time, while both hands 33 and 33a may be associated with the movement of escapement mechanism 26. The calibration illustrated in Fig. 3 is arbitrary, the proper calibration being that best suited to the particular adaptation or application of the system.

Figs. 4, 5, 6 and 7 depict modifications of

the system for generating electrical energy of my invention. The section containing the indicating mechanism has been omitted from these illustrations. However, similar arrangements to those shown in the preceding illustrations may be employed. Shaft 5a, herein illustrated, may be of solid material, metal or insulation or of spring steel. An adjustment screw 38 serves as a bearing and support for one end of shaft 5a. Bearing 38 is supported by member 4 which in turn is carried by base 1 by screws 4a.

Upstanding member 3 serves as a support for electromagnet 11. Electromagnet 11 has a core 13 electromagnetically related to armature 12. Armature 12 is positioned on shaft 5a, in an arrangement similar to that shown in the drawings previously described. A connecting arm 40 extends from shaft 5a which is associated with mechanically vibratile element 8a. Element 8a may comprise a section of material having piezo electric properties such as quartz or may be spring steel or other material having resilient properties. The metal may be coated with a thin layer of quartz or other piezo electric material. One end of element 8a is held in position by member 39. In Figs. 4, 5 and 6, mechanical tension is applied to mechanically vibratile element 8a by means of shaft 5a and arm 40. In Fig. 7, a connecting arm 42 is pivotally connected with members 40 and 41. By the latter arrangement it is possible to control the movement of mechanically vibratile element 8a within the desired limits by the proper adjustment of members 40, 41, 41a and 42. Electrodes 31, and 32 contact with the surfaces of mechanically vibratile element 8a in suitable manner to collect the potential difference between opposite sides of member 8a, and conduct the same to an external circuit.

Figure 8 is a schematic circuit diagram showing an adaptation of the generating system of my invention embodying certain modifications. Mechanically vibratile element 8 is actuated by armature 12, which is associated with shaft 5 as shown in the previous figures. Contact members 30 and 31 connect with the surfaces of mechanically vibratile element 8 by means of which the difference of potential is transmitted to the electrical circuit associated therewith. Thermionic tubes 42, 43, 44 and 45 are connected in suitable amplifier circuit arrangements, herein illustrated as resistance coupling, which may however be transformer or impedance coupling. Thermionic tubes 42, 43, 44 and 45 each have cathodes 46, 47, 48 and 49, control electrodes 50, 51, 52 and 53 and anodes 54, 55, 56 and 57, respectively. Source of electrical energy 58 is connected with the cathodes. Source of electrical energy 59 is connected with the anodes. The alternating current generated between contact members or electrodes 31—32

is transferred to the input circuit of thermionic tube 42. The variations of potential impressed upon the control electrode 50 and cathode 46 circuit of thermionic tube 42, cause variations of current in the output circuit of thermionic tube 42. Like variations of potential of increased amplitude are impressed upon the input circuit of thermionic tube 45 and like variations of current are present in the output circuit of thermionic tube 45. The output circuit of thermionic tube 45 includes inductance 63 and the windings of electromagnets 11 and 11a, all of which are connected in series. The amplified current variations generated by piezo electrical element 8 are therefore employed to reinforce the production of such current variations. If the polarity of the charges developed on the faces of mechanically vibratile element 8 and the polarity of electromagnets are in the proper phase relation, an aiding effect causes the mechanical strain to which the element is subjected to reach a maximum. The elastic or resilient properties at this time react in opposition to the torque or bending moment exerted by the balance wheel and the motion of the wheel or twisting direction of the mechanically vibratile element is reversed. The reciprocating motion continues so long as power is furnished the amplifier system.

Many modifications of the electrical generating system of my invention are possible without departing from the spirit of my invention. Many different circuit arrangements and thermionic tubes other than the type illustrated may be employed, and I desire that it be understood that the embodiments of my invention are not to be restricted by the foregoing specification or by the accompanying drawings but only by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. In a system for generating alternating current, a piezo electric crystal element, a fixed support holding one end of said piezo electric crystal element in fixed position, a rotatable element clamping the end of said crystal element opposite the end held in fixed position, a support for rotatably supporting said rotatable element, electromagnetic means for applying torsional moment to said rotatable member successively in opposite senses and causing said rotatable element to rotate with oscillations of small amplitude, and electrodes attached to said piezo electric crystal element for delivering electrical energy therefrom when torsion is applied to said crystal by said rotatable element, said electrodes being connected to said electromagnetic means, whereby said electromagnetic means sustains regular periodic vibrations of said crystal of frequency corresponding to the natural frequency of said crystal.

sponding to the natural frequency of said crystal.

2. In a system for generating alternating current, a piezo electric crystal element, a fixed support holding one end of said piezo electric crystal element in fixed position, a rotatable element clamping the end of said crystal element opposite the end held in fixed position, a support for rotatably supporting said rotatable element, electromagnetic means for applying torsional moment to said rotatable member successively in opposite senses and causing said rotatable element to rotate with oscillations of small amplitude, electrodes attached to said piezo electric crystal element for delivering electrical energy therefrom when torsion is applied to said crystal by said rotatable element, and an amplifier having its input connected to said electrodes and its output connected to said electromagnetic means whereby said electromagnetic means sustains regular periodic vibrations of said crystal of frequency corresponding to the natural frequency of said crystal.

3. In a system for generating alternating current, a piezo electric crystal element, a fixed support holding one end of said piezo electric crystal element in fixed position, a rotatable element clamping the end of said crystal element opposite the end held in fixed position, a support for rotatably supporting said rotatable element, electromagnetic means for applying torsional moment to said rotatable member successively in opposite senses and causing said rotatable element to rotate with oscillations of small amplitude, said electromagnetic means comprising an armature carried by said rotatable element and an electromagnet mounted adjacent said armature, and electrodes attached to said piezo electric crystal element for delivering electrical energy therefrom when torsion is applied to said crystal by said rotatable element, said electrodes being connected to said electromagnetic means, whereby said electromagnetic means sustains regular periodic vibrations of said crystal of frequency corresponding to the natural frequency of said crystal.

4. In a system for generating alternating current, a piezo electric crystal element, a fixed support holding one end of said piezo electric crystal element in fixed position, a rotatable element clamping the end of said crystal element opposite the end held in fixed position, a support for rotatably supporting said rotatable element, an inertia member carried by said rotatable element, electromagnetic means for applying torsional moment to said rotatable member successively in opposite senses and causing said rotatable element to rotate with oscillations of small amplitude, and electrodes attached to said piezo electric crystal element for delivering electrical energy therefrom when torsion is applied to said crystal by said rotatable element.

said electrodes being connected to said electromagnetic means, whereby said electromagnetic means sustains regular periodic vibrations of said crystal of frequency corresponding to the natural frequency of said crystal.

5 5. In a system for generating alternating current, a piezo electric crystal element, a fixed support holding one end of said piezo electric crystal element in fixed position, a
10 rotatable element clamping the end of said crystal element opposite the end held in fixed position, a support for rotatably supporting said rotatable element, electromagnetic means for applying torsional moment to said rotatable member successively in opposite senses
15 and causing said rotatable element to rotate with oscillations of small amplitude, and electrodes attached to said piezo electric crystal element for delivering electrical energy
20 therefrom when torsion is applied to said crystal by said rotatable element, said electrodes being connected to said electromagnetic means, a clockwork indicating mechanism, means mechanically connecting said
25 clockwork mechanism to said rotatable element for transmitting rotative motion from said rotatable element to said clockwork mechanism and indicating the rotation of said rotatable member whereby said electromagnetic
30 means sustains regular periodic vibrations of said crystal of frequency corresponding to the natural frequency of said crystal.

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